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Design and Development of Box Shifting Mechanism Using Gearless Power Transmission System

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Abstract:- This paper represents the review and study of the literature available in the context of our proposed project. The paper largely focuses on two different mechanisms, namely, Box Shifting Mechanism and Gearless Power Transmission Mechanism as these are very important for our project. In this paper, we have tried to give a brief on various literature published, one by one. It has covered the analysis of the work done in these published papers such as Design, Calculations and Fabrication part. It has also covered the conclusion part of their papers. The main objective of this study is to learn and understand about these two very interesting mechanisms. And also to find new ideas which we can interpret and implement into our proposed project.

Keywords:- *Gearless Power Transmission, Linkage Mechanism, Bent-Link Mechanism, Crank, Conveyor.*

I. INTRODUCTION

In our project, we are trying to combine the two different mechanisms, namely, Box Shifting Mechanism and Gearless Power Transmission Mechanism. These mechanisms are very unique yet simple in nature and have their own significance in industrial applications. We'll discuss in brief about these two mechanisms.

So, starting with the Box Shifting Mechanism, it is a simple mechanism which is operated with the help of a crank and link arrangements. In this mechanism, the rotary motion of a Crank results into the back and forth linear motion of the Linkage Mechanism. This back and forth linear motion of the Linkage Mechanism helps boxes on the conveyor to move further.

Now, coming to the Gearless Power Transmission Mechanism, which can also be called as the Bent-Link Mechanism. It is very simple yet unique Mechanism. In this, the Links which will connect the two cylindrical plates, are bent at 90°. Thus, it is a very useful mechanism for transmitting the power at right angles.
So, In this paper, We have analyzed different types of literature published and tried to get the idea of design and development of the project.

II. WORKING

The project, as discussed, is the combination of two different mechanisms. One is Box Shifting Mechanism and the another one is Gearless Power Transmission Mechanism. The set up consists of similar Circular Plates with drilled holes at the Pitch Circle Diameter of 100mm. The two circular plates are then connected with the help of three Links. These three links are bent at an angle of 90°. There are two shafts connected to the two circular plates. These shafts can also be called as driver and driven shafts. The links and circular plates are connected to one side into the driver and the other in the driven shaft. Further, the driven shaft is extended towards the Crank of the Box Shifting Mechanism. Box Shifting Mechanism consist of Linkage Mechanism which include Upper Structure, Couplers and connecting rods. Upper Structure is a very important component of this mechanism which will be used for the movement of boxes. Both of this Mechanisms are supported on the Base Structure.

When the power is transmitted to the shaft, it starts rotating. This is a driver shaft which is already connected to the first circular plate. This circular plate starts rotating with the help of driver shaft. As we have stated earlier that the three bent links are connected to these two circular plates. So, because of this, the power transmission to the second circular plate becomes possible. While transmitting the power from one circular plate to another, the bent links starts reciprocating inside the drilled holes of these plates. This allows the two circular plates to move smoothly. Thus the power can be transmitted to the second Shaft which is a driven Shaft. This is the simplest way to transmit motion between intersecting shafts. Driving and driven shafts rotate continuously. There is very less to no friction in the moving parts of the transmission system. When the power is Transmitted through the Gearless Transmission Mechanism to driven shaft, because of the rotation of the Shaft, Crank connected to it also rotates. The rotary motion of the crank is transferred to the Couplers and then the power gets transmitted to the upper structure. This way the rotary motion gets converted into the linear motion. Now, because of this the Upper Structure starts moving back and forth, resulting into the linear movement of the boxes.

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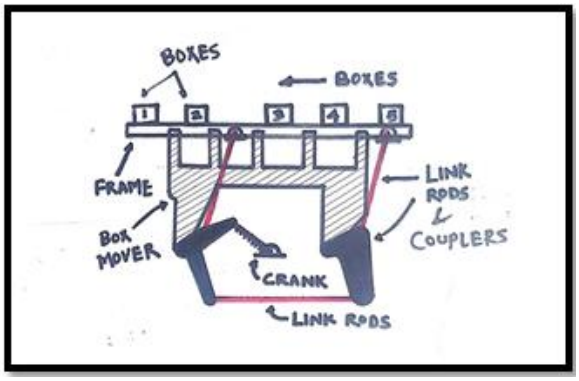
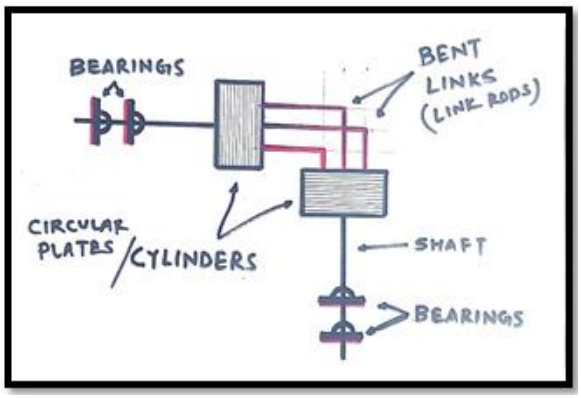
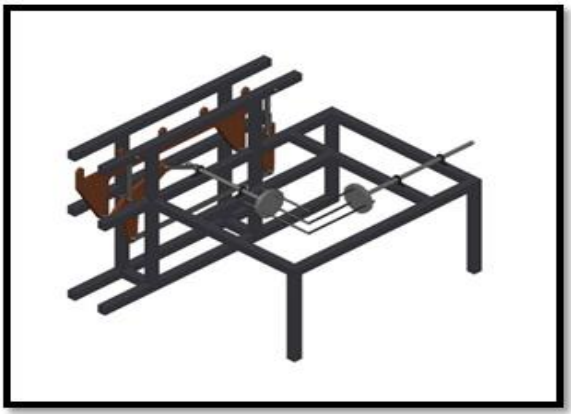
III. PROPOSED DESIGNS



Linkage Mechanism



Gearless Power Transmission Mechanism



Proposed Model

IV. REVIEWS

In this section we'll analyze the different literature available in the context of our project. We'll study the literature to learn what is suitable and beneficial for our project. There have been few studies conducted on the topic of Box Transport Mechanism and Gearless Power Transmission. We'll look into this studies one by one.

- Aatharv Keskar in the 'International Journal of Advance Research in Science Engineering and Technology', Vol. 7, Issue. 1, January 2020, worked on the design and the fabrication part of the Box Shifting Mechanism. We analyzed that the project consist of few components like upper structure, base structure, linkage Mechanism etc. According to the author, the main objective of the project was to design a Mechanism which is helpful for the intermittent movement of the packages. Different types of planar linkage Mechanisms were analyzed and the crank rocker Mechanism found suitable for this work. It further says that the crank can move at 360°, a rocker can rotate through a limited range of angles which doesn't include 0° or 180°. We found that the designs of the main components like Upper Structure and Crank were made on Hyperworks CAE Software. It is also mentioned that DC wiper motor is being used because of its low rpm and high Torque capabilities. The only drawback is that the speed of motor is low so it may not be useful in large scale production purposes. There were very less calculations provided but still We believe that the the project work is satisfactory.

- P. R. Kothule, M. R. Chavan, S. P. Bhalerao in '7th International Conference on Science, Technology & Management', 25th February 2017, worked on Box Transfer Mechanism through kinematic links. They focused on the fabrication part of the Mechanism which included main operations like Drilling, Arc Welding, Grinding and Assembling. They had used DC motor of around 10 rpm which is very low. The boxes that were to be transferred from one place to another were of light weight. The dimensions of the boxes were also given as 220mm×80mm×80mm. The length of the track on which the boxes move is about 44 inches and height is about 36 inches. The material used were mainly Wood and Mild Steel. The use of Wood reduces the weight of a mechanism which we liked the most in this project. We have also decided to make use of Wood in our project wherever possible. They concluded that this project work might be useful in all industries. For practical applications, this is fabricated for light duty operations. Its height, weight and other mechanical designs may be not suitable for any other heavy operation or work on hardened material. This is a drawback of this project but still considering it's going to be used for light duty operations, we feel the authors have done a very good job which will surely help us in our work.

- Mohd. Mohtashim Danish, Tushar S. Nitnawre, Piyush Pagar in 'International Journal of Advance Research in Science and Engineering', Vol No. 06, Issue No. 01, January 2017, worked on the similar project of Box Transport Mechanism. They have used the crank rocker type mechanism. The specifications of this mechanism is very similar to the earlier project we discussed. Here, they've used few components like Linkages, DC motor, Wooden Frame and Bearings. According to them, this easy and simple to use prototype design will revolutionize the concept of box transfer mechanism. As it is easy to use and fabricate, small scale industries will be able to utilize this product for the betterment in the plant management. There were no Calculations included in the paper so we believe the Calculations were not performed or stressed upon. As transporting boxes from the assembly line will get more manageable, industries could easily increase their production rate and so their

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revenue. Further advancements and modifications can be done as per the requirements as well as scale of the use, according to them.

- Dr. G. Diwakar, G.P.S. Narendra, G.S.V. Gopal Prakeerthi, D. Mahesh Naidu, G. Revanth in 'International Journal of Innovative Science and Research Technology', Vol. 5, Issue. 11, November 2020, worked on the topic of 'Design and Simulation of Box Transport Mechanism'. According to them, this project tries to replace the treadmill mechanism in small scale industries. They added that different fasteners such as pins, end-threaded bolts with nuts, and loosely fitted rivets are used so that the Linkages move freely. This type of fasteners will also be used in our project. They developed model which is light weight and can be used in small scale industries. They conclude that the accurate mathematical model and simulation for the kinematics, dynamics, and motion analysis of the machine can be very useful for the precise application and also Further advancements and modifications can be done as per the requirements. The paper has provided the areas of Applications and also the future scope of their project. But the paper does not give any proper idea of the calculations performed. Hence, this may not be very much reliable on that part but the other work is satisfactory.

- 'R. Somraj and B. Sailesh in 'International Research Journal of Engineering and Technology', Vol. 04, Issue. 04, April 2017, Worked and Analyzed the Design and Fabrication of Gearless Transmission For Skew Shafts. The authors argued that, this system allows the changing in the orientation of shafts during motion and they are trying to replace crossed helical gears or worm gears or hypoid gears which are very complex for manufacturing for this purpose. The main components in this system were bent links of 8 mm diameter along with two shafts of 20 mm diameter and four bearings. The Hub, in which the bent links are inserted with the help of drilled holes, is of 92 mm diameter and 82 mm long. The Calculations were also performed resulting into the Torque of 1238 N.mm, with the power of 186.5 W. The rpm was considerably high at 1440 rotations per minute. They considered about 25% Overload on Max. Tensile stress and Max. Shear stress as 60 N/mm^2 and 40 N/mm^2. Bending stress for shaft is 186.64 N/mm^2 and Tensional shear stress of shaft 112.57 N/mm^2. The only drawback we see in this paper is that they gave illustration of symmetrical shafts and not the skew shafts. So, it becomes a bit complicated for a learner to understand. Finally, they concluded that the system can be used for any set of skew shaft diameter but the shaft must be having the rotational motion about it's own axis.

- Neeraj Patil, Jayesh Gaikwad, Mayur Patil, Chandrakant Sonawane, Shital Patel in 'International Journal of Innovative Research in Science, Engineering and Technology', Vol. 6, Issue. 3, March 2017, worked and researched on Gearless Transmission Mechanism and its Applications. Their main focus was to build a go-kart transmission layout to which the wheels are attached from the outside. Now this can be called as an extension of Gearless Power Transmission. The fabrication consist of a layout on which two Gearless Transmission systems are fit. The Driving shafts are placed parallel to each other and the driven shafts are placed opposite to each other. The hubs and bent links are also connected to these Shafts. Links are bent at required angle slide inside the drilled holes in the hub. Since there are two input shafts, two separate motors can be used but the rotation must be in opposite direction. Otherwise Cross belt drive can also be used. The weight of this model along with rider was assumed as 150 kg. Diameter of each link was 10mm. The calculated Torque was about 46.67 N.m. Calculations on Links of C45 material were performed separately. For example, Torque on each link is 15.55 N.m. Tangential force is 311.15 N and the Maximum Stress was 45 N/mm^2. The speed achieved by 1hp motor was 806.72 rpm. After study of the mechanism it was said that this mechanism is mainly applicable to low cost applications where torque is low to medium. With future development in low friction materials, the efficiency and capacity of this mechanism can be increased. Also if bolted links or links held by universal joints are used then transmission is possible even when angle changes, they suggested.

- Mr.Unawane Uday S, Ms.Shirsath Nita, Mr.Narode Sanket, Ms.Ghugarkar Akshada, Ms. Shingavi Archana. A in 'International Advanced Research Journal in Science Engineering and Technology', Vol. 05, Issue. 04, April 2018 worked on the topic of 'Gearless Power Transmission Through Elbow-Rod Mechanism and to Compare it with Bevel Gear Mechanism for Wood Cutter Application'. We observed that the main purpose of this paper was to prove how Gearless transmission system is better in comparison to the Geared system. They've provided a specific differentiation between these two systems such as Manufacturing Cost, Lubrication, Torque capacity etc. The construction and working of their mechanism is same as we've seen in other gearless transmission projects. The paper does not provide any idea of how this mechanism will be further used for the wood cutting operations. The paper, also, does not provide any idea of how the Calculations were performed. So, overall, it was a satisfactory project.

- Meet Patel, Dharmik Parikh, Parth Parmar, Sarmesh Patel in 'International Journal of Mechanical Engineering and Technology', Vol. 10, Issue. 07, July 2019 worked on Gearless Power Transmission. This project is a bit unique kind of a project. The group worked on a system where the Driven Shaft can move from one side to another on a semi-circular track at 180°. It is being supported on a slot or a track on which it can move. The bent links are not bent at the right angle rather they're cut in the half and again loosely fit with the help of nuts and bolts to compliment the free movement of a driven shaft at 180°. The few components used were rotating flanges, bearings and a base structure. The paper provides the conceptual drawings of the machine and its

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components, so it become easy to understand. Again, the paper does not provide any idea of how the Calculations were performed. There is no mention of Calculations, only the concept and procedure of machine design is discussed. Overall, it was a good concept and the work is also satisfactory.

- S. S. Pawar, Ankur Naidu, Panigopal Vallabhaneni in 'International Conference on Emanations in Modern Engineering Science and Management', (ICEMESM-2018) presented a study on Gearless Transmission through Elbow Mechanism. This project is also very similar to the above projects we have seen in this paper on the topic of Gearless Power Transmission. The paper discuss about the literature that they've referred in order to develop this project, in very brief. The paper gives an idea of all the main components of this Mechanism in the form of sketches. It also gives different views such as front view, top view etc. of the components. According to their methodology, first they studied the research papers. Then they performed design of shafts, rod and bent links. Simulation is also performed to find out various stresses acting. Fabrication and Assembly were also performed. But the Calculations are missing in this paper. So, we didn't get any proper idea of what and how much stresses were acting on the components. Still, the project was successfully completed and the outcomes were satisfactory, they concluded.

- Solanki Nehal Parmesh, Patel Harshil K., Singh Montu, Rajwani Avesh in 'International Journal of Scientific Research in Engineering, Vol. 1 (3), March 2017, worked on Design And Analysis Of Gearless Transmission Through Elbow Mechanism. This fabricated model was a bit different. They used four bent links in their model. This was a bit unique, in a way. Their argument was that this mechanism will replace bevel gears used for transmitting power between the two shafts placed at an angle between 0 - 120°. The bent links which they used was about 10mm diameter. The Calculations were done using Torsion and Bending Moment equations. The Allowable Torsion Stress and Bending Stress is 101.2 N/mm^2 and 211.6 N/mm^2. Torque was about 4.94 N.m on 1440 rpm of 746 W motor. Also, Simulation of mechanism is carried out for performing static structural analysis on the mechanism to see the response of the elbow rods, hub and shaft. Simulation is performed for 4, 6 and 8 pins/elbow rods which are running at 50, 100, 150 and 200 rpm for the two different materials ,namely, Mild Steel and Stainless Steel. It has been concluded from the analysis that, the stresses and deformation on four-elbow rod and hub mechanism is more than a six-elbow rod mechanism. The mechanism with six-elbow rods made up of mild steel material works perfectly and smoothly when it is kept at 150 RPM. They concluded by saying that more number of links can be very useful for the smoother operation of the Mechanism.

V. CONCLUSION

We have gone through all the papers published, as shown above. Few of them covered Box transport Mechanism and others covered Gearless Power Transmission Mechanism. We found that most of the projects were very similar to each other but few changes and modifications were made here and there. Many of them were simply the extensions of these two Mechanisms. For example, one of the project group included a Skew Shaft in their mechanism and designed it. Generally, the bent link mechanism uses three links to connect the two circular plates, but one of the project group used four links in their mechanism instead of three. One of them mainly focused on the application part of the project. So, we can say that these were basically the extensions of the two above discussed mechanisms.

The above analysis and study of various project literature will surely help us in the design and development of our project. We're very thankful to all the members of each project group and also the Publishers who encourage new researchers to present their Innovative Ideas in this field.

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